that when the Röntgen rays pass through a dielectric they make it during the time of their passage a conductor of electricity, or that *all substances when transmitting these rays are conductors of electricity.* The passage of these rays through a substance seems thus to be accompanied by a splitting up of its molecules, which enables electricity to pass through it by a process resembling that by which a current passes through an electrolyte. By using a block of solid paraffin in which two pairs of electrodes are embedded, the line joining one pair being parallel, that joining the other pair perpendicular, to the Röntgen rays, which were kept passing through the block, I found that there is but little difference between the rate of leakage along and perpendicular to the rays.

I have much pleasure in thanking Mr. J. A. McClelland, of Trinity College, Cambridge, and Mr. E. Everitt for the assistance they have given me in carrying out these experiments.

A telegram from Professors Borgman and Gerchun, of St. Petersburg, forwarded by the editor of the 'Electrician,' to the effect that Röntgen rays discharged electricity, and a letter from Professor Lodge to the effect that he had definitely ascertained that the phosphorescent glass was the source of the radiation of Röntgen rays, and that the radiation starts in all directions, and not normally only from the glass, were read.

IV. "On the Absorption of the extreme Violet and ultra-Violet Rays of the Solar Spectrum by Hæmoglobin, its Compounds, and certain of its Derivatives." By Arthur Gamgee, M.D., F.R.S., Emeritus Professor of Physiology in the Owens College, Victoria University. Received February 11, 1896.

In the year 1878 the late Professor J. L. Soret, of Geneva, in his first memoir on the absorption of the ultra-violet rays of the spectrum by diverse organic substances,* announced the fact that diluted blood, when examined with the aid of a spectroscope provided with a fluorescent eye-piece, presented in the extreme violet, between Fraunhofer's lines G and H, an absorption band which appeared to him to be slightly shifted towards the less refrangible end of the spectrum when the blood solution was saturated with carbonic oxide. Soret subsequently† confirmed the accuracy of the above

* J. L. Soret, "Recherches sur l'Absorption des Rayons ultra-violets par diverses Substances," 'Archives des Sc. Phys. et Nat.,' vol. 61 (Geneva, 1878), pp. 322–359.

† Soret, 'Archives des Sc. Phys. et Nat.,' vol. 66 (1883), pp. 194, 195, and 204.

facts, employing the photographic method in his experiments. Since the date of the publication of Soret's short notes on this subject, d'Arsonval* has independently, and without referring to Soret's observations, described anew the extreme violet absorption band of the blood-colouring matter, but without adding to the facts discovered by the Swiss observer.

The complete absence of all reference to Soret's scanty, but interesting and suggestive, observations, in text-books and treatises on physiology and physiological chemistry, the fact, which my observations soon elicited, that the absorption band of Soret is much more distinctive of the blood-colouring matter than the absorption bands in the visible spectrum which have hitherto engrossed the attention of observers, led me to interest myself in an investigation which promises to throw much light on the relations of the blood-colouring matter to other organic proximate principles, and on the transformations which the blood-colouring matter undergoes in the animal economy.

In this paper it is my object merely to communicate some of the more interesting results which I have hitherto obtained, a full discussion of the details of the research, which are of special interest to physiologists and physiological chemists, being reserved for future publication.

My observations have, for the most part, been carried out with the aid of a spectrometer furnished with a quartz prism and quartz lenses, and the observations were made with the help of photography.

The substances which will be referred to in the statement of results are the following:—

1. Oxy-hæmoglobin. 2. Hæmoglobin. 3. The CO- and NO-compounds of Hæmoglobin. 4. The iron-containing products of decomposition of hæmoglobin and of oxy-hæmoglobin, viz., Hæmochromogen (reduced hæmatin) and Hæmatin. 5. Methæmoglobin. 6. Hæmatoporphyrin. 7. Bilirubin, Hydrobilirubin, and Urobilin.

The following are some of the principal results of the investigation:—

I. The compounds of hæmoglobin with oxygen, carbonic oxide, and nitric oxide present, even in highly dilute solutions, an absorption band between Fraunhofer's lines G and H. As a result of a large number of measurements, I conclude that in the case of oxy-hæmoglobin the mean ray absorbed coincides with λ 414·0, that is to say, the centre of absorption is slightly nearer the red end of the spectrum than Soret had stated; this observer placed the centre of absorption at h (λ 410·1).

* A. d'Arsonval, 'Arch. de Physiologie Norm. et Patholog.,' 5me série, vol. 2 (1890), pp. 340—346.

As Soret had indicated, in the case of the compound of carbonic oxide with hæmoglobin, the absorption band is slightly displaced towards the less refrangible end of the spectrum. The combination of hæmoglobin with nitric oxide presents an absorption band occupying precisely the position of that of the CO-compound.

In the case of these two compounds, the mean ray absorbed corresponds to λ 420·5.

II. When the molecule of *dissociable* oxygen is removed from oxyhæmoglobin, either by the action of reducing agents, or by boiling *in vacuo*, the absorption band in the extreme violet is remarkably displaced towards the less refrangible end of the spectrum, the centre of absorption corresponding to λ 426·0. When we reflect that the addition of a molecule of oxygen to the enormous molecule of hæmoglobin cannot affect in an appreciable manner the mass of the molecule, we must conclude that the displacement of the absorption band towards the ultra-violet end when hæmoglobin combines with oxygen (all other conditions remaining the same), indicates that this combination leads to a notable acceleration of the intra-molecular movement, which is the cause of the absorption of the extreme violet rays by hæmoglobin.

III. The absorption of the extreme violet depends on the iron-containing moiety of the hæmoglobin molecule, for, whereas it is not presented by the albuminous product of the decomposition of the blood-colouring matter, it is characteristic of the acid compounds of hæmatin and of hæmochromogen.

IV. Solutions of alkaline hæmatin, even when enormously diluted (1 : 30,000 of water), exert a general absorption of the ultra-violet and extreme violet, but present no trace of definite absorption, either in the extreme violet or the adjacent ultra-violet region.

The compounds of hæmatin with acids, *e.g.*, hæmatin hydrochloride, present even in solutions of great dilution (1 : 25,000—1 : 50,000) an intense absorption band, which encroaches more and more on the ultra-violet as the strength of the solution increases. In a solution containing one part of crystallised hæmatin hydrochloride in 20,000 parts of glacial acetic acid the band extends between *h* and M, the most intense absorption being between *h* and L. The less refrangible border of this band is sharply defined, whilst the more refrangible border is less definite. As the solution is diluted, the band becomes narrower, through less and less of the ultra-violet being absorbed. In highly dilute solutions the band which is still intense absorbs both H and K.

The acid compounds of hæmatin exhibit, therefore, an absorption band, which is exactly on the boundary of the ultra-violet proper, and which extends further and further into the ultra-violet as the concentration of the solution increases.

V. Solutions of hæmochromogen (reduced hæmatin of Stokes) exhibit an intense absorption band between *h* and G. The band has the same position as the band of CO-hæmoglobin, but is more intense. With one part of hæmochromogen in 25,000 parts of water (the stratum examined being 10 mm. thick), an intense absorption band occupies the region between λ 410·0 and λ 430·0. From the examination of solutions of various strengths, it results that the mean ray absorbed corresponds to λ 420·0.

VI. The absorption of the extreme violet and ultra-violet by methæmoglobin indicates that this body is the product of a partial decomposition of the molecule of oxy-hæmoglobin.

VII. The band in the extreme violet (and ultra-violet), which is characteristic of hæmoglobin, its compounds, and certain of its iron-containing derivatives, in no respect depends upon the iron in the molecule. This conclusion is based (1) on the fact that none of the compounds of iron, organic or inorganic, possess the property of producing a definite absorption in the extreme violet or the adjacent ultra-violet; (2) upon the study of hæmatoporphyrin, a body derived from hæmatin by the removal of the iron which this body contains.

Acid solutions of hæmotoporphyrin of extreme dilution exhibit an absorption band between *h* and H. If the solution be slightly more concentrated K is absorbed, and with increasing concentration of the solution the absorption of the ultra-violet extends more and more. Alkaline solutions of hæmatoporphyrin absorb the same spectral region, but the intensity of the absorption is greater.

VIII. Neither bilirubin, hydrobilirubin, nor urobilin present any definite absorption band in the region of the spectrum where the absorption band of hæmoglobin and its derivatives occurs.

Presents, February 13, 1896.

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